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IDEALS OF THE TELEPHONE SERVICE[1]

A TRIBUTE TO THE MEMORY OF ALEXANDER GRAHAM BELL

THIS is the ninth annual meeting of the Telephone Pioneers of America, although our association is now entering upon its twelfth year. On account of the war, during three years no annual meetings were held. The pioneers were then engaged in the great struggle to save civilization.

The membership of our association is made up not only from those who took part in the first development of the telephone, but also from those who have been in the telephone service for a period of twenty-one years. We have in the service tens of thousands of zealous men and women doing pioneer work now, but because they lack in years, though not in achievement, they have not been enrolled. We and they are looking forward to the day of their formal admission. To these our fellow-workers we extend our greetings and our appreciations. In their hands lies not only the future of our society but the future of our art.

Our first meeting took place eleven years ago, at Boston, the birthplace of the telephone. At that meeting, the inventor of the telephone, Alexander Graham Bell, was present and delivered to us an address which must always be memorable in the history of our society. To-day, we recall with peculiar sadness these words which he then spoke to us:

"This is a great day for me, the first meeting of the Telephone Pioneers of America and of the world. It gives me great pleasure to meet with you all to-day, and yet there is a feeling of sadness about it. I am the first telephone pioneer and my memory goes back to the very beginning, and I miss the faces I remember so well, the faces of the old pioneers who I wish were here to-day. . . . I feel it a little presumptuous on my part to try to speak of the telephone

[1] Presidential address delivered at the ninth annual meeting of the Telephone Pioneers of America, at Cleveland, Ohio, September 29, 1922.

to telephone men. You have all gone so far beyond me. Why, the little telephone system that I look back upon, what is it compared to the mighty system that goes through the whole extent of our country to-day? It is to you that this great telephone development is due, and I feel that it behooves me to speak very modestly of the little beginning that led to this great end. I can not tell you anything about the telephone. I can not speak to you about undulating current, intermittent current and pulsatory current. I belong to the past; you belong to the present.''

Here stand revealed those lovable qualities of the great pioneer—generosity and modesty—which endeared him to us all. It is true, indeed, that he belongs to the past, though then he still belonged to the present. Now he belongs to the ages.

Alexander Graham Bell died on Wednesday, August 2, at the age of seventy-five, at his summer home in Nova Scotia, near Baddeck. He was buried on August 4, at sunset, on the summit of a mountain overlooking the Bras d'Or Lakes. As a tribute to his memory, telephone service was suspended for one minute throughout the United States and Canada during the simple ceremony.

The manifold activities of his life, devoted to the service of mankind, would require volumes to portray. The medals and other honors which he received from learned societies, his honorary degrees from universities at home and abroad, and special recognition by governments, all testify to the esteem in which he was held. His scientific researches in the field of heredity and eugenics, his experiments in aeronautics, his work in improving the phonograph and in teaching the dumb to talk, and his invention of the photophone, reveal the scope of his mind. This record alone is enough to insure his fame, but his discovery of the method of transmitting articulate speech by electricity, and his invention of the apparatus to do this, have placed his name among the immortals.

Dr. Bell was born on March 3, 1847, in Edinburgh, Scotland. He went to Canada in 1870, and the next year, at the age of twenty-four, he removed to Boston. After introducing into New England schools improved methods of teaching deaf mutes to speak, he was appointed professor of vocal physiology in Boston University.

In his spare time, he conducted experimental researches in electrical wave transmission. He was assisted financially in these experiments by two gentlemen of Boston, Thomas Sanders and Gardiner Greene Hubbard. By the summer of 1874, he had worked out his theory that the transmission of speech by electricity could be accomplished by producing "electrical undulations similar in form to the vibrations of the air" which accompany the original words or sounds. In spite of great difficulties and discouragements, he succeeded in reducing his theory to practical form, when, at Boston, in the summer of 1875, he invented a telephone which faintly transmitted parts of words and even entire words.

Mr. Thomas A. Watson, Bell's assistant, relates that it was on March 10, 1876, over a line extending between two rooms in a building at No. 5 Exeter Place, Boston, that the first complete sentence was ever spoken and heard through the electrical telephone. It was spoken by Bell and heard by Watson, who recorded it in his note book at the time. It consisted of these words: "Mr. Watson, come here; I want you." Thus the telephone was born.

After completing his fundamental invention, Bell in a remarkable document predicted with amazing foresight the telephone system of the future. He also invented the photophone, which was the first method of transmitting speech by electricity without wires, and the induction balance and the telephone probe for which he was awarded the honorary degree of doctor of medicine by the University of Heidelberg. To his successors in the laboratories in which he was the original worker, he left the further conduct of telephone research and development.

Turning to other departments of science, he displayed his remarkable intellectual gifts by the fruitful researches which he conducted. In his work on behalf of the deaf, which he continued to the end, is revealed a dominant motive in his life.

To Bell was accorded a privilege so often denied to those who have advanced the world by their discoveries—he lived to see the triumph of his great idea. When the first sentence was transmitted, the public regarded the telephone as a scientific toy. Then, the telephone plant of the entire world could be carried

in the arms of a child. To-day, vast telephone systems of intercommunication have been developed, extending the spoken word among the peoples of the nations.

The advances of the telephone art made by the successors of Bell were always a source of great satisfaction to him. Some of these, epoch-making in their nature, gave him special gratification.

On January 25, 1915, the transcontinental line, spanning Bell's adopted country from ocean to ocean, was in the presence of dignitaries of state and nation dedicated to the public service. This was a day of triumph for Bell, for, using a reproduction of the original instrument, he once again spoke the memorable words, "Mr. Watson, come here; I want you." But this time Bell was at New York, and Watson, who heard him with perfect ease, was three thousand miles away in San Francisco.

Another advance attained the greatest distance over which the transmission of speech had ever been achieved. Early in the morning of September 30, 1915, words were spoken through a radio telephone at Arlington, Virginia, to the Hawaiian Islands, where they were plainly heard. But, as if to proclaim the telephonic conquest of time as well as space, the words reached these distant islands of the Pacific when it was there still the evening of September 29.

There yet remained to be realized that prophetic dream of the telephone pioneers—the bridging of the Atlantic by the human voice. But the day of its fulfilment was not far off, for on October 21, 1915, during the dark days of the war, speech was for the first time in history successfully transmitted across the Atlantic Ocean. This was accomplished by the radio telephone, which carried the words spoken at Arlington to the Eiffel Tower at Paris.

The last memorable telephone development destined to occur in the life of Bell will always be associated with a great historic occasion. At the burial of the Unknown Soldier at Arlington, on November 11, 1921, the voice of President Harding, by means of the new loud speaking amplifiers, was easily heard by the great concourse of a hundred thousand people about him, even by those in the most distant parts of the vast cemetery. Corresponding multitudes numbered by tens of thousands, at New York and San Francisco, heard over the wires every word spoken by their chief magistrate, as clearly as though in his actual presence. These distant multitudes heard also the invocation of the chaplain, the music and the hymns and the words of the commitment service used by the bishop at the grave. They joined with each other and with those at the cemetery in the singing of the hymns, and they united with the President in reciting the Lord's Prayer with which he closed his address. They heard in amazement the salvos of artillery fired at the grave, and even those on the shores of the Pacific caught the loud reverberations thrown back by the Virginia hills. At the end, in profound silence and with heads bowed in sorrow, they listened to the plaintive notes of the trumpet sounding the soldiers' last farewell.

On that day, the achievements of science imparted a mystical power to the most solemn national ceremony in the history of America. This ceremony, its deep significance so enriched by the art of Bell, we can now believe contained an exalted sanction of the greatest of all the achievements of his life.

These are but some of the advances which have been made in the first half century of the telephone art, which is now drawing to a close. They belong to the golden age of communications which has achieved the extension of the spoken word throughout both space and time.

But this golden age has not yet ended, and when we contemplate the possibilities of the future we discover that it has only just begun. It is to the future that we must now turn our minds and direct our endeavors. It is true that we pioneers belong to the past, but it is equally true that we belong to the present. As individuals, we must all pass away, as did the first pioneer; but our association, the Telephone Pioneers of America, will continue to live. The greatest work which our society can do is to exemplify the ideals of our service, and to transmit to its future members the splendid traditions of our art. It should be our purpose to encourage and to sustain among the men and women of the telephone system their ever-increasing zeal for the public service.

While it is beyond my power to put into words these ideals of our service, they already

exist within your hearts and mine, where we all can feel, though I can not express, their potency. These feelings, which form the mainspring of our actions, do not arise from mere wishful thinking, nor do they spring from an idealism which is disconnected from reality. They rest upon a solid basis of achievement, and represent the practical purpose of that great telephone system of intercommunication which bears the name of our first pioneer.

It is interesting to note that the biologists were the first to appreciate the peculiar importance of electrical communications in the social organism, and to Herbert Spencer, writing more than fifty years ago, we are indebted for some analogies which have not yet been sufficiently studied either by the biologist or the engineer. In tracing the analogy between the telegraph system of his day and the nervous system of the animal organism, Spencer expressed the view that probably when the then rudimentary telegraph systems were more fully developed, other analogies would be traceable. This development has already been provided by the telephone art, and national telephone networks have now become a vital part of the social organism. I believe that the study of these networks from the standpoint of biology is destined to yield important results, and, indeed, that an investigation of the remarkable developments of the automatic machinery used in modern telephone switchboards might even throw light on the mechanism of the mind itself.

Scientists have long been studying the theory that man has advanced to his present high estate by upward progress in the biological scale from a microscopic speck of protoplasm forming the biological cell or unit of life. They have pictured him as composed of countless millions of these living creatures forming an organic entity marvelously designed, each cell performing its allotted part in that exquisite division of labor which characterizes this biological state.

We commonly compare a nation to a complex living organism. "We speak of the body politic, of the functions of its several parts, of its growth and of its diseases, as though it were a creature. But we usually employ these expressions as metaphors, little suspecting," as Spencer says, "how close is the analogy, and how far it will bear carrying out. So completely, however, is a society organized upon the same system as an individual being, that we may almost say that there is something more than analogy between them."

Each cell has its allotted and specialized work to do. Each cell must be fed, and live, and grow. Sustenance must be obtained, prepared and assimilated, and the waste removed. The physiological mechanisms for doing these things and many other things besides have their striking counterparts in the structure of organized society, and furnish instructive material for the philosophic student. But to us of the telephone art, the most marvelous thing of all is the nervous system, that inconceivably complex communication network, by which the activities of both individual and society are regulated and without which paralysis and death would result.

We are told that the cells which compose the nervous system are the latest to appear in the upward march of the organism, and that the degree of their complexity and the extent of their differentiation furnish a criterion for determining the stage of progress which has been attained. Because of the high function, almost spiritual in its nature, performed by these nerve cells, they have been called the noble cells. I have long felt and often expressed the feeling that because of this the workers in the telephone art are engaged in a high calling, building up the noble cells which constitute the nervous system of the nation.

As in the animal body these cells were the latest to appear, so in the structure of organized society the highest form of electrical communication, the telephone, is the latest to appear—it comes only at the stage of higher development. And again as in the animal body, the stage of development of the nervous system is an index of its place in the evolutionary series, so I believe it will be found in any social organism that the degree of development reached by its telephone system will be an important indication of the progress which it has made in attaining coordination and solidarity.

The use of the spoken word to convey ideas distinguishes man from all other created things. The extension of the spoken word by means of electrical systems of intercommunication serves

to connect the nervous system of each unit of society with all of the others, thus providing *an indispensable element* in the structure of that inconceivably great and powerful organism which many biologists feel is to be the ultimate outcome of the stupendous evolution which society is undergoing.

That such an organism, thus so magnificently conceived, would be the outcome of the higher evolution of man, I have long believed; but its form and the nature of its functioning, I could not imagine. But the great work of Trotter, who has studied the gregarious instinct in the lower animals and in man, permits us to contemplate this evolutionary entity from a new point of view. He has pointed out that nature, having failed in her giant organisms, in which so many individual cells were crowded into such animals as her giant lizards and the mammoth and the mastodon, was to try a new method which was to dispense with gross physical aggregations of cells combined into one body. He points out that the flock, the herd, the pack, the swarm—new organizations—were to be devised by nature, and to flourish and range throughout the world, and that in one of these new organizations, human society, the individual man is still to be regarded as the unit, but not constrained as is the cell in the animal body, but free to move about, the mind alone being incorporated into the new unit by the marvelous power of intercommunication. He shows that the power of these organisms depends on the capacity for intercommunication among their members, and that this power expands until the limits of this intercommunication are reached.

How fundamental electrical communication systems are, in the tremendous evolution of the human race which is now being manifested in the organization of society, and how vital to the welfare of mankind is the daily work of telephone men and women everywhere, is being made more and more apparent by the discoveries of the new school of biologists.

Speaking always of communication in its broadest meaning,[2] but emphasizing the importance of speech, Trotter says: "The capacity for free intercommunication between individuals of the species has meant so much in the evolution of man, and will certainly come in the future to mean so incalculably more, that it can not be regarded as anything less than a master element in the shaping of his destiny."

And again, in speaking of human society as a gregarious unit, he says: "The ultimate and singular source of *inexhaustible* moral power in a gregarious unit is the perfection of communion amongst its individual members."

As long as intercommunication was limited, he tells us, the full possibilities of nature's new experiment were concealed. But at length appeared man, a creature endowed with speech, in whom this capacity for intercommunication could develop indefinitely. "At once a power of a new magnitude was manifest. Puny as were his individuals, man's capacity for communication soon made him master of the world. . . . In his very flesh and bones is the impulse towards closer and closer union in larger and larger fellowships. To-day he is fighting his way towards that goal, fighting for the perfect unit which nature has so long foreshadowed, in which there shall be a complete communion of its members, unobstructed by egoism or hatred, by harshness or arrogance or the wolfish lust for blood. That perfect unit will be a new creature, recognizable as a single entity; to its million-minded power and knowledge no barrier will be insurmountable, no gulf impassable, no task too great."[3]

Here we have portrayed the forward march of humanity toiling ever onward to attain its goal. The realization that their wonderful art is destined to play such an important part in this final attainment, opens up a never-ending source of power and inspiration for telephone men and women everywhere. It adds new dignity to their calling. Already, as we have seen, the human voice has been carried with the speed of light across the Atlantic Ocean, and across our continent, and far out into the Pacific; but still greater things are to come.

It is the mission of the pioneers and their successors, and their associates among all the nations, to build up a telephone system extending to every part of the world, connecting

[2] In this should be included all methods of communication based upon speech, such as newspapers, books and letters, depending upon mechanical transportation; and telegrams, depending upon electrical transmission.

[3] W. Trotter: "Instincts of the Herd in Peace and War."

together all the peoples of the earth. I believe that the art which was founded by Alexander Graham Bell, our first pioneer, will provide the means for transmitting throughout the earth a great voice proclaiming the dawn of a new era in which will be realized that grandest of all our earthly aspirations—the brotherhood of man.

JOHN J. CARTY

AMERICAN TELEPHONE AND TELEGRAPH COMPANY, NEW YORK

THE AGGLUTINATION OF BACTERIA[1]

ONE of the characteristic properties of suspensions of finely divided matter in general and of bacteria in particular is the fact that under certain conditions the particles remain discrete, whereas, under other conditions, they collect into larger aggregates, *i. e.*, they agglutinate. This aggregation or agglutination is caused by certain concentrations of salts or acids and in the case of suspensions of bacteria by proteins and especially by the homologous immune serum. It is evident, therefore, that there must be a force which tends to keep the individual particles apart from each other, and another force which tends to hold them in contact. It has long been known that such particles carry an electric charge with reference to the surrounding liquid and it was early suggested that it was the repulsion due to the charge carried by the organisms which prevented them from coming into contact; the attractive force has usually been assumed to be surface tension. Many experiments have been performed to test this relation of the charge on the particles to the stability of the suspension, but nearly all have failed to show any definite relationship between the two phenomena. An exception is the work of Powis[2] on the coagulation of oil emulsions. Powis found that coagulation occurred whenever the potential between the drops and the surrounding liquid was reduced below a critical value of about 30 millivolts. The stability of these oil emulsions therefore is determined solely by the potential of the droplets. In the case of bacteria, however, it has been found repeatedly that agglutination, especially by immune serum, may occur without any change in the potential. Some qualitative relation has been found between the acid agglutination point and the potential inasmuch as the potential passes through a minimum and changes its sign at the acid agglutination point.

It will be evident from the result of the experiments reported here that the difficulty with the bacteria suspensions is due to the fact that electrolytes affect not only the potential and hence the repellent force but also the cohesive or attractive force. In order to account for the observations it is therefore necessary to measure *both*.

The experiments performed by the writers were carried out with thoroughly washed suspensions of *B. typhosus* and the bacillus of rabbit septicemia. The potential was calculated from the rate of migration of the organisms in an electric field.

AGGLUTINATION BY SALTS OR ACIDS

It was found that the experiments could be divided at once into two groups; first, those in which agglutination was caused by very low concentrations (less than 0.01 N), and second, those in which high concentrations of electrolytes were needed. In the first group it was found that agglutination occurred whenever the potential between the organisms and the solution was reduced below about 13 millivolts (either positive or negative). In this case apparently the stability is determined solely by the potential. In the second group, however, there was no critical potential and agglutination with many salts did not occur even though the potential was reduced to a value too small to measure. This distinction between the two groups is not due to a specific effect of the salt, since the presence of a high concentration of sodium chloride for instance, which does not cause agglutination in any concentration, completely prevents agglutination by acids.[3]

[1] A detailed account of the work described in this paper has been published in the *J. Gen. Physiol.*, July and November, 1922. References to other work will also be found in these papers and have been omitted from the present summary.

[2] Powis, F.: *Z. physik. Chem.*, 1914-15, lxxxix, 186.

[3] It follows from this experiment that in determining the acid agglutination point of bacteria

It is evident from the above results that the agglutination in general can not be accounted for solely by changes in the potential. The results, however, are what might be expected if the salt affected the attractive or "cohesive" force as well as the potential. It was found possible to obtain a comparative measure of the adhesive force by determining the force required to separate two glass discs covered with a film of the bacteria. These experiments confirmed the supposition mentioned above. They showed that high concentrations of salt decreased the attractive force between the organisms. Although the potential required to keep them apart is also decreased, and in very concentrated salt is reduced to zero, the cohesive force is so insignificant that the organisms do not agglutinate, despite the absence of potential.

AGGLUTINATION BY MEANS OF PROTEINS

The agglutinating action of various proteins was found to be the same as that of salts, except that no effect on the cohesive force was noted. The addition of the protein affects the potential and if the potential is decreased below the critical value agglutination occurs. If the potential is *increased* the suspension becomes more stable. This is evidently part of the mechanism of the so-called "protective colloids." The amount of protein required to reduce the potential to the critical value and to cause agglutination varies markedly with the p_H and is much less when the protein and bacteria carry charges of opposite sign. When the bacteria and protein both have the same sign, the charge on the bacteria may be *increased*. This experiment shows conclusively that the union between protein and bacteria is not determined solely by the attraction due to opposite charges since according to this view no combination should occur when the two have the same sign. It appears probable that the union is governed by secondary valence forces and is of the same type as the reactions studied by Langmuir in the formation of surface films. The isoelectric point of organisms coated with a protein is changed to that of the protein.

buffer solutions of high concentration should not be used, but the experiments should be made with dilutions of a suitable acid.

THE MECHANISM OF AGGLUTINATION WITH NORMAL AND IMMUNE SERUM

The effect of normal or immune serum was found to depend on the conditions of the experiment, especially as regards the salt concentration. If dialyzed serum is added to a suspension of organisms in distilled water, the potential of the organisms is gradually decreased but not sufficiently to cause agglutination (in the case of typhoid bacilli), *i. e.*, the potential is still greater than 13 millivolts. If *any* salt solution is now added to this mixture until the potential is decreased to the critical value of 13 millivolts, agglutination occurs. In other words, the immune serum prevents the salt from decreasing the cohesive force between the organisms and the agglutination of organisms treated with immune serum is determined simply by the potential. The agglutination of organisms sensitized with immune serum therefore takes place whenever sufficient electrolyte is added to reduce the potential to the critical value of about 13 millivolts. An excess of trivalent ions or of some divalent ions may cause the potential to change its sign and become greater than the critical value again, in which case the suspension again becomes stable.

If the experiment is performed in the usual way by adding the serum to a suspension of the organisms in salt solution, the mechanism is different. As has already been stated, the addition of ordinary neutral salts such as NaCl in fairly high concentrations to a suspension of bacteria depresses the potential to a very small value but agglutination does not occur owing to the fact that the cohesive force is also decreased, so that although there is no force keeping the organisms apart, neither is there any force to draw them together and no agglutination occurs. If now immune serum is added to this suspension of bacteria in salt solution it is found that very little or no change is caused in the potential but that the cohesive force is increased and agglutination therefore takes place. When the experiment is performed in this way, therefore, the mechanism is just the reverse of the one described above in which the salt was added to the mixture of serum and organisms. When the salt is added to the mixture

of serum and organisms the cohesive force remains constant, but the potential and therefore the repulsion between the organisms is decreased until it is less than the cohesive force and agglutination therefore occurs. When, however, the serum is added to the organisms in the presence of sufficient salt so that the potential is less than 13 millivolts, the cohesive force is increased with increasing concentration of serum until it is greater than the repulsion due to the potential (which is not affected by the addition of the serum) and agglutination again occurs.

INFLUENCE OF THE p_H

It was found that the acidity of the solution markedly affects the amount of either normal or immune serum required to cause agglutination (when the organisms are suspended in low concentrations of salt). The nearer the isoelectric (acid agglutination) point of the organism the less serum is required for agglutination. A determination of the amount of antibody combined with the organism, however, showed no increase in this range. The number of units combined was the same from p_H 3.5 to p_H 8, although the amount of serum required to cause agglutination varied tremendously over this range of p_H. The same amount of antibody when combined with the organisms therefore evidently has a far greater effect in this range of p_H than it has farther from the isoelectric point or else other constituents of the serum have a greater effect near the isoelectric point of the organism. In any case, there seems to be no connection between the sign of charge of the antibody and organism and the combination between the two. This experiment indicates that the serum or protein forms a film on the surface of the organism which then reacts like a particle of the pure protein. A similar mechanism was suggested by Coulter[4] to account for the effect of serum on the acid-agglutination point of red blood cells.

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FOR MEDICAL RESEARCH,
NEW YORK

[4] Coulter, C. B.: *J. Gen. Physiol.*, 1921-22, iv, 403.

THE WORK OF U. S. GEOLOGICAL SURVEY

EXPLORATIONS for potash, investigations and explorations of present and possible oil and gas fields, of coal fields, and of ore deposits and mining districts, paleontologic researches, work in chemistry and physics, and investigations of surface and underground water resources are among the year's activities of the United States Geological Survey as mentioned in the annual report of the director, just made public. The number of employees in the Geological Survey holding regular appointments was 877; most of them are field men whose varied work ramifies into every state, in addition to Alaska and other outlying territory of the United States. Besides these a small host of temporary camp field men were employed—rodmen, teamsters, cooks, etc. Some of the most important things that the Geological Survey has to show for its work are geologic surveys which cover a wide scope of practical and scientific activity, embracing 32 states; topographic mapping in 21 states covering 13,544 square miles and including more than 5,000 miles of levels and primary traverse lines; more than 11,000 measurements of stream flow in 31 states and investigations of underground waters in 10 states.

The survey also acted on more than 25,000 cases referred to it in connection with the administration of the public lands; and made a decrease of 3,914,000 acres in outstanding government coal reserves, of 110,000 acres in outstanding petroleum reserves, and of 298,000 acres in phosphate reserves. There was, however, a net increase of 268,000 acres in the area classified as phosphate land. The present acreages classified and reserved by the government as coal, petroleum, oil-shale and phosphate lands are: Coal, 65,000,000; petroleum, 6,500,000; oil-shale, 4,100,000; phosphate, 2,700,000. The survey also made a net increase of 635,000 acres in power-site reserves, designated 382,000 acres in Nevada under the ground-water reclamation act, and made net increases of 5,700 acres in public water reserves, of 3,989,000 acres in enlarged-homestead designations, and of 4,778,000 acres in stock-raising homestead designations. The Washington office distributed 602,000 copies of book publications

and 695,000 maps, of which 562,000 maps were sold.

The Geological Survey is a scientific bureau which has to do with the mineral resources of the earth rather than with men. Therefore it is known to but comparatively few, for to most people its reports seem to lack human interest. The work of its large topographic force, for instance, is recorded in lines on paper—maps—which do not lend themselves especially well to columns in the newspapers. Where the Geological Survey leaves off others take hold. Thus the geologist may carefully explore and outline on a map the structure of an oil field, and so advise the wildcatter where or where not to drill; yet little public interest attaches to the region until the oil man sets up his rig and begins to drill. So it is with all the work of the organization; it is basic, foundation work, upon which many kinds of development may rest later, after the Geological Survey has moved on to new fields of investigation.

An example of the forward-looking policy of the Geological Survey is seen in its anticipation last winter of the coal strike, when as a measure of preparedness, in cooperation with the census, it made an inventory of the amount of coal stored in the United States, and also prepared and published a map of the United States showing the coal mining districts.

The work of the Geological Survey in connection with oil, says the director, continues to be of increasing value, and the application of geology to practical affairs is shown by the fact that in four oil fields that have been extensively developed the early geologic mapping indicated the existence of oil in the ground, which was later proved by commercial development. Other activities of the Geological Survey included examination of deposits of oil-shale in four states; comprehensive studies of the Colorado and San Juan rivers in Utah and Arizona with reference to reservoir sites; the completion of studies of radium-bearing carnotite ores and tungsten deposits of the United States; the preparation of timely reports on the production of coal and other fuels; making nearly 2,000 detailed analyses of rocks and minerals, and 700 analyses of surface and underground waters; the preparation of special physical and shaded relief maps of Alaska, California, Kentucky and several other areas; continuation of the preparation of the United States portion of the international map of the world, for which maps of 46 states have now been completed and are on sale at nominal prices; the preparation of monthly reports on the production of electricity and consumption of fuel by public utility power plants; and the publication of maps of 14 states showing the location of power sites and transmission lines. These in common with all the 3,000 or more different maps of the Geological Survey are for sale at nominal prices.

SCIENTIFIC EVENTS

VITAL STATISTICS OF PRUSSIA BEFORE AND AFTER THE WAR[1]

THE Prussian Statistical Department issued last year the second part of Vol. 10 of *Medizinalstatistische Nachrichten.* It is a comparative study of the last complete pre-war and the first complete post-war year (1913 and 1919). Prussia is closely comparable with England and Wales in population, and as it has been exposed to different wartime and post-wartime conditions, it is interesting to compare the results. The estimated population of Prussia in 1913 at all ages was 20,596,269 males and 21,052,793 females. In the first completed post-war year (1919) the census showed a decrease in the males to 18,816,849 and females to 20,523,598. The mean age of males in 1913 was 26.6 years, and 28.7 in 1919. There was very little change in infant mortality, the death rate per 1,000 births in the first month of life being 48.7 for 1913 and 48.3 for 1919. The births numbered 1,209,385 in 1913 and 827,335 in 1919, giving rates of 29.0 and 21.0 per 1,000 living. In England and Wales the birth rates were 23.9 per 1,000 living in 1913 and 18.5 in 1919, and the death rates in the first month of life were 44.39 and 44.49 per 1,000 births. In both countries there was an increase in the deaths in childbed, but the third wave of the great pandemic of influenza in 1919 may be assumed to account for some increase. In Prussia the decline in infantile diarrhœa was considerable; the mortality under 1 year was 134.6 per 10,000 live births in 1913 and 44.55 in 1919. Excluding typhoid fever and influenza, the infectious diseases showed a decrease. The

[1] *The British Medical Journal.*

number of deaths from scarlet fever in 1919 was less than half that of 1913, being 2,213 against 4,506. In England and Wales 2,100 deaths were registered in 1913 and 1,221 in 1919. The deaths from measles showed a greater decline, from 7,286 to 1,270. The figures for England and Wales were 10,673 and 3,563. There was little change in the deaths from diphtheria and croup, the actual deaths being 7,550 and 7,054, and the rates of mortality at ages up to 15 were 5.42 in 1919 and 5.20 in 1913 (mortality per 10,000 living). The figures for England and Wales were 4,494 for 1913 and 4,916 for 1919, and the rates of mortality under 15 years 3.84 and 4.36 per 10,000. In Prussia the death rates from typhoid fever increased from 0.34 to 0.74 (actual deaths being 1,433 and 2,911). There was a decline in the figures for England and Wales from 1,505 to 577 (0.41 to 0.16 per 10,000). The greatest increase in the causes of deaths was under the head of tuberculosis. The totals were 56,861 in 1913 and 85,996 in 1919, and the crude rate per 10,000 increased from 13.65 to 21.86. The rates for urban districts increased from 15.81 to 27.16 and the rural from 11.65 to 16.84. In England and Wales the total deaths were 49,464 in 1913 and 46,310 in 1919. "The special characteristic of the mortality from tuberculosis in the years under consideration and that which gives rise to the greatest anxiety is the increase of mortality at young ages. Despite the end of the war, the partial improvement of feeding, clothing and heating, normal facilities for medical treatment, and above all the declining birth rate, which would give reason to suppose that more and better attention under the more favorable external conditions of a smaller family would lead to a decline of the death rate, the number of deaths has not in fact declined but increased, a result which is doubtless to be attributed to the aftermath of the hunger blockade." The statistics of pneumonia and influenza show the effect of the great pandemic in 1919. The deaths from influenza were 1,592 in 1913 and 29,141 in 1919. In England and Wales the figures were 6,387 in 1913 and 44,789 in 1919, but the two sets of figures are not comparable owing to the differences in tabulation. The total mortality from influenza and pneumonia was 53,094 and 85,990 in 1913 and 1919, and the corresponding figures for England and Wales were 44,002 and 83,909. The cancer rate shows very little change, 10.13 in 1913 and 10.03 in 1919 for 10,000 persons at ages 30 to 60, and for persons over 60, 54.16 and 51.14. In 1920 the rate increased to 10.22 (ages 30 to 60), and 55.05 (60 and over), the latter being the highest yet recorded.

THE AMERICAN SCHOOL IN FRANCE OF PREHISTORIC STUDIES

FOR the year's work from July 1, 1922, to July 1, 1923, three scholarships were offered of five thousand, three thousand and two thousand francs, respectively. There were over fifteen applicants representing nearly as many states of the Union. The successful applicants are Miss E. L. Bayles, Smith College 1921, of Cincinnati; Mr. Noguera, formerly at Harvard University, of Mexico City, and Mr. J. H. Goff, Oglethorpe University 1920, of Macon, Georgia. Besides these three, three other students completed the summer's work, and one more spent a month in study in the field.

The work consisted in excavation at the station of La Quina in the forenoon, and in attendance at lectures in the laboratory of Dr. Henri Martin, near by, in the afternoon: of these, one was given by Dr. Martin, who accepted a position on the staff as lecturer in paleontology, and a second by the director on prehistoric archeology in general.

The results of the excavations themselves may be said to be satisfactory. The trench continued in 1921 under Director MacCurdy, was extended and proved of somewhat varying richness. The specimens found were predominantly Mousterian, but Acheulean tendencies were not lacking, nor were those of Aurignacian quality (in the upper part). In addition, a small grotto was excavated to a distance of eight meters; the somewhat scanty (though interesting) specimens found here proved almost exclusively Aurignacian. Animal bones, particularly those of the horse, bison and reindeer, were abundant and (as is usually the case) a large number of teeth were preserved.

Excursions were made to Les Eyzies, Teyjat, a neighboring Merovingian cemetery, etc., and at the end of September the students undertook an excursion to the caves of Gargas, Mas

d'Azil, Tuc d'Audubert and Trois Frères in the Pyrenean region.

The winter's work is undertaken by the three scholarship holders and the others: the latter hope to remain in Paris as long as possible.

The school would not have existed had it not been for the generosity and kindness of Dr. Henri Martin and his family. In encouragement, scientific assistance and in hospitality they have added one more season of incomparable enthusiasm; the director and the students are deeply appreciative of this, as well as of the kindness of M. Hubert of the Museum of Saint Germain, and of Mr. Passemard, of Biarritz, who generously delivered lectures before the school on the Neolithic, Bronze and Iron Ages and on the Cavern of Isturitz.

CHARLES PEABODY, *Director*

THE NATIONAL ASSOCIATION OF AUDUBON SOCIETIES

THE National Association of Audubon Societies, of which T. Gilbert Pearson is president, is making an appeal for funds for a permanent home. Founded in 1901, the association to-day is the largest membership organization in the world having for its object the study and protection of wild birds and wild animals.

The association feels that its usefulness could be greatly augmented and the influence of the Audubon Societies of America largely increased, both in this country and abroad, if the headquarters could be installed in a building adequate to its needs, a building providing suitable accommodations for a library of conservation and natural history, photographic exhibits, a museum of conservation, for displaying apparatus for attracting birds and for an assembly hall.

Adequate space is needed to house the library of ornithology and general natural history, as well as various phases of conservation of wild life, which has passed the twelve hundred mark and is constantly growing. Much rare and unreplaceable data dealing with the conservation of wild birds and animals is included, which should be stored in a fireproof building where it may be accessible to the students of to-day and those of the future. At present almost half of the library is in boxes in storage warehouses because of lack of space.

A demand exists for specific knowledge regarding bird sanctuaries and reservations on public lands as well as private estates. It is also believed that the public would be interested in the association's collection of punt-guns, traps, snares, nets and other illegal devices used in taking wild birds, as well as in the various species of birds which are now or have been extensively used in the millinery feather trade. Quantities of these seized from dealers by the state and federal authorities are in the hands of the association.

Besides the library of conservation, the museum and the exhibition hall, the need is felt for an assembly hall where teachers and others interested in bird study might attend lectures and meetings. Additional office space and more storage room are also needed.

LECTURES AT YALE UNIVERSITY ON MENTAL HYGIENE

UNDER the auspices of the department of social and political science of Yale University and the New Haven Council of Social Agencies, a course of eight lectures on the "Social aspects of mental hygiene" will be given by a group of specialists who have attained prominence in the mental hygiene movement. The movement was started in New Haven in 1908 by Clifford W. Beers, who organized at that time the Connecticut Society for Mental Hygiene. From the beginning the university has sponsored his work and a number of Yale professors have been identified with it.

This course represents an attempt to meet the need expressed by social workers and others for instruction in the field of mental hygiene. The adjustment of human relationships, which is the main object of all social work, calls for knowledge of personality and its development, and an understanding of the relation of mental disorder and mental defect to dependency, delinquency and general social maladjustment. The course is also designed to be of assistance to parents, teachers and others in the community who desire a clearer and more practical understanding of the intricate mechanism of human behavior.

President Angell will act as chairman of the first lecture, which Mr. Beers will give. Dr. O. G. Wiedman, medical director of the Connecticut Society for Mental Hygiene, will preside at four of the lectures, and Dr. Paul

Waterman, chairman of the State Psychopathic Hospital Commission, at the last three.

The following subjects will be discussed: "The mental hygiene movement," Mr. Beers; "The mechanism of human behavior," Dr. Frankwood E. Williams, medical director of the National Committee for Mental Hygiene and editor of the *Mental Hygiene Quarterly;* "Mental hygiene and personal health," Dr. Thomas W. Salmon, of the Rockefeller Foundation; "Mental hygiene and education," Dr. C. Macfie Campbell, director of the Boston Psychopathic Hospital; "Mental hygiene and family life," Dr. Abraham Myerson, assistant professor of neurology at Tufts College; "Mental hygiene service for children," Dr. Arnold Gesell, professor of child hygiene, Yale University, and director of the University Psycho-Clinic; "The feeble-minded in the community," Dr. Walter E. Fernald, superintendent of the Massachusetts School for the Feeble-minded; "Mental hygiene in social work," Dr. Jessie Taft, director of the Department of Child Study of the Children's Aid Society and Children's Bureau, Philadelphia.

SCIENTIFIC NOTES AND NEWS

Dr. John Trowbridge, Rumford professor emeritus at Harvard University, died at Cambridge on February 18 in his eightieth year.

Dr. John Dow Fisher Gilchrist, professor of zoology in the South African College at Capetown, has been elected president of the South African Association for the Advancement of Science for the meeting to be held at Bloemfontein in July.

Marston T. Bogert, professor of organic chemistry, represented the National Academy of Sciences at the Benjamin Franklin Celebration in Park Row, New York City, on January 17. In the name of the academy, he presented a floral tribute in the form of a lightning flash, bearing the initials of the National Academy of Sciences and "symbolizing both Franklin's harnessing of the lightning and the brilliance of his scientific genius."

Dr. Dawson Turner and Mr. D. M. R. Crombie have each been awarded a Makdougall-Brisbane medal by the Royal Scottish Society of Arts for their paper on "An investigation of the ionized atmosphere around flames by means of an electrified pith ball."

Dr. William Hoskins, of Chicago, consulting chemist, has been elected a director of the American Chemical Society.

The South Africa medal and grant have been awarded to Dr. I. B. Pole Evans for his contributions to botanical science in South Africa.

Professor F. C. Newcombe, instructor in botany in the University of Michigan for the last 33 years, and for the last 20 years head of the department, having reached the retiring age, has resigned his position and will leave the university at the end of the present academic year. Professor H. H. Bartlett has been elected chairman of the department.

Dr. Anders Sven Hedin, of Stockholm, who spent thirteen years exploring Thibet and Eastern Turkestan, arrived in New York on February 13 on the Hamburg-American liner *Hansa.* He will lecture and will also visit American Indian ruins.

Arriving in Berkeley on February 8, Dr. A. Sommerfeld, professor of mathematical physics in the University of Munich, was for two weeks a guest of the department of physics of the University of California. He delivered a largely attended course of eight lectures on atomic structure and theories of radiation to the graduate students of that and related departments.

The Clinical Congress of the American College of Surgeons, representing thirty-five states, is making a 14,000 mile cruise to South America, including Brazil, Uruguay, Chili and the Argentine. The party is composed of five hundred persons, including one hundred and sixteen American and Canadian surgeons and their families. The cruise, which will last two months, was arranged by Dr. Franklin H. Martin, of Chicago, and Dr. William J. Mayo, of Rochester, Minn.

Dr. James F. Kemp, professor of geology at Columbia University, will go to Porto Rico late in February to make a survey of the mineral resources of the island for the New York Academy of Sciences. He will also assist in a reconnaissance of the Virgin Islands preparatory to detailed geological investigations. Dr. Nathaniel L. Britton, director in chief of the New York Botanical Garden, sailed from New

York with Mrs. Britton on January 20 to prosecute their investigation of the flora of Porto Rico. The work is partly in press now and when completed will be published by the New York Academy of Sciences. Dr. Fred J. Seaver, also of the Botanical Garden staff, accompanied Dr. and Mrs. Britton at the special request of the Porto Rican government. He will make an intensive study of the fungi of the island from an economic aspect, and will return with the rest of the party on April 5.

AMONG grants made, as we learn from *Nature*, from the Bonaparte fund of the Paris Academy are: 2,000 francs to Wilfred Kilian to assist the publication of a geological bibliography of the south-east of France; 5,000 francs to Emmanuel de Margerie, for the preparation of the publication of a tectonic map of Eurasia; 15,000 francs to Jean Mascart, for the publication of a part of the astronomical work of Luizet; 3,000 francs to M. Mugnier-Serand for his researches on atmospherics in wireless telegraphy and their application to the prediction of storms; 15,000 francs to the Academy of Sciences for the publication of the catalogue of scientific periodicals in Paris libraries.

FROM the Loutreuil fund of the Academy 5,000 francs have been given to the Association lyonnaise for excavations in the prehistoric deposits of Solutré, and 2,000 francs to Charles Le Morvan for the publication of a map of the moon.

AT the annual general meeting of the British Association of Economic Biologists, held on Friday, January 26, the following officers and council were elected for the year 1923: *President,* Professor E. B. Poulton, F. R. S.; *Treasurer,* Dr. A. D. Imms; *Secretaries,* General and Botanical, Dr. W. B. Brierley; Zoological, Dr. J. Waterston; *Editors,* Botany, Dr. W. B. Brierley; Zoology, Mr. D. Ward Cutler; *Council,* Dr. W. F. Bewley, Professor V. H. Blackman, F.R.S., Mr. F. T. Brooks, Mr. A. B. Bruce, Dr. E. J. Butler, C.I.E., Dr. J. W. Munro, Sir John Russel, F.R.S., Professor J. H. Priestley, D.S.O., Professor J. H. Ashworth, F.R.S., Dr. T. Goodey, Mr. A. D. Cotton, Mr. W. E. Hiley. Professor V. H. Blackman and Sir John Russel were appointed vice-presidents.

DR. CHARLES GREELEY ABBOT, of the Smithsonian Institution, will speak before the Syracuse Astronomical Society on March 2, at 8 o'clock. Before the lecture there will be a dinner in honor of Dr. Abbot.

PROFESSOR E. V. MCCOLLUM, of the Johns Hopkins University, addressed the Public Health Association of Rochester and the Rochester Section of the American Chemical Society on February 2 on "Diet and health."

DR. A. J. MCLAUGHLIN, surgeon of the United States Public Health Service, former commissioner of public health of Massachusetts, addressed the annual meeting of the Boston Health League at the Twentieth Century Club on February 14 on "The control of communicable diseases."

AT the annual general meeting of the British Association of Economic Biologists, held at the Imperial College of Science on January 26, Professor R. T. Leiper, M.D., gave an address on the study of helminthology.

A LECTURE on "Intersexuality and the determination of sex" was delivered by Professor Goldschmidt, of the University of Berlin, at the University of Liverpool on February 15.

SIR EDWARD SHARPEY SCHAFER, professor of physiology in the University of Edinburgh, has accepted the invitation of the trustees to be the first Victor Horsley lecturer. The lecture will probably be delivered in the autumn.

PROFESSOR ZSCHOKKE, of the faculty of zoology in the University of Basle, is lecturing this term at the University of Cambridge on the European fauna.

A PROGRAM commemorative of the work of Charles Goodyear, who did the original work on the vulcanization of rubber in and near New Haven, will be given by the Rubber Division of the American Chemical Society at the spring meeting. The division plans the erection of a tablet in Goodyear's memory. It also is the announced intention of Dr. Bruni, of Milan, Italy, to be present at the meeting and to present a paper on his late researches on the acceleration of vulcanization.

CARL PAUL GOERZ, founder and until the time of his death head of the Optische Anstalt C. P. Goerz A. G., of Berlin, died on January 14. Mr. Goerz started in business in 1886 in

a single room. The Goerz factories now cover several acres in Berlin-Friedenau and Berlin-Zehlendorf, with branch factories in Cassel, Leipzig and several other places. At the present time there are over three thousand employees, making practically everything required in the photographic and scientific field. Mr. Goerz was sixty-nine years old and remained to the last the active head of these enterprises.

Mr. E. W. Nelson, the scientific superintendent of the marine laboratory at the Bay of Nigg near Aberdeen, died on January 17.

The one hundred and nineteenth meeting of the American Physical Society will be held in Room 301, Fayerweather Hall, Columbia University, New York, on Saturday, February 24, 1923.

The anniversary meeting of the Royal Anthropological Society was held in London on January 23.

The Royal Microscopical Society has established a section to deal with the practical use of the microscope in connection with industrial research.

At the International Exhibition of Photography, Optics and Cinematography, to be held at Turin in May and June next, prizes will be given for various kinds of films—among others, films of scientific subjects.

We learn from the *Journal of Industrial and Engineering Chemistry* that after conducting exhaustive hearings on the bill to appropriate funds for the recovery of the helium which is constantly going to waste from the natural gas wells of the southwest, the committee on public lands of the House of Representatives has decided that the bill should have gone to the committee on military affairs in the first place. The result is that there is no possibility of passage of the bill at this session.

The Bermuda Biological Station will be open for research this summer, as usual, for some six weeks or more, beginning early in June. The laboratory is provided with running sea water, the needful glassware and usual reagents, but does not furnish microscopes, dissecting instruments or other personal apparatus. It has accommodations for a limited number of persons who desire to pursue investigations on specific biological topics; but no formal instruction will be given. The facilities of the station are offered free of charge to competent investigators. Special, very low, rates for transportation from New York to Bermuda and return are guaranteed. Persons desiring to take advantage of this opportunity should communicate promptly with the director of the station, who will be glad to furnish additional information as to facilities and expenses. Applicants should state the nature of the investigation proposed, the animals or plants which will be needed in the work, and any special appliances desired, addressing the director, Professor E. L. Mark, Museum of Comparative Zoology, Cambridge 38, Massachusetts.

Between July 1 and October 1, 1923, there will be no routine teaching of undergraduate students at Stanford University Medical School. During this period properly qualified graduates in medicine and medical students of this and of other schools are invited to participate in medical and surgical work, including specialties, in the capacity of special workers. The workers will be expected to assist in the diagnosis and treatment of patients in the outpatient departments, laboratories and wards. Opportunity to make special studies of clinical and laboratory problems will be offered in certain subjects. The minimum period of attendance will be four weeks. Applications, which should give an outline of the medical experience of the applicant, should be sent to the Dean, Stanford University Medical School, 2398 Sacramento Street, San Francisco, before June 1, 1923. A more detailed statement will be sent on application.

Three donors have given $6,000,000 to the endowment fund of the New York Public Library—John D. Rockefeller, Jr., $3,000,000; Payne Whitney, $2,000,000; Edward S. Harkness, $1,000,000. Added to the present fund of approximately $15,500,000 the amount will enable the library now to operate its reference department without a deficit and to make up arrears in binding, cataloguing and purchasing, but $500,000 more annually will be necessary to meet the natural development of the library. The number of books consulted annually has increased one hundred per cent. in eleven

years, and the annual number of readers 200 per cent., from 400,275 in 1911 to 1,225,778 in 1922. Cost of operation advanced 113 per cent. in the same period.

THE *British Medical Journal* states that the announcement is made from Canada that 2,715 claims have already been received for the prize of $100,000 offered by Lord Atholstan, of Montreal, for the discovery of a cure for cancer; claims have come from forty-one different countries. It is pointed out, however, that claimants must satisfy a recognized medical faculty or leading medical society in his or her own country first that there is some scientific basis to justify the experimental investigation of the professed cure, and that any cases said to have been successfully treated were in fact cases of cancer.

UNIVERSITY AND EDUCATIONAL NOTES

SUBSCRIPTIONS to the Harvard endowment fund reached a total of $13,892,605.29 on January 1, according to figures now made public. Of the sum, $10,910,825.31 had actually been paid in on that date, against a corresponding figure a year earlier of $9,776,766.89.

A BEQUEST of $200,000 for the establishment of a department of clinical surgery has been ordered paid by trustees of the estate of Edward A. W. Hunter to the University of Pennsylvania by Judge Thompson in the orphans' court. The fund awarded the university will establish the "Agnew and Hunter Department of Clinical Surgery" in memory of Drs. D. Hayes Agnew and Charles D. Hunter.

A BILL now pending in the Texas Legislature provides for an appropriation of $200,000 for the establishment of a State College of Technology and Textile Engineering.

J. LEIGHTON STUART, president of Peking University, has announced a contingent gift of $75,000 by the China Medical Board of the Rockefeller Foundation. Mr. Stuart recently arrived in the United States to speak in the interest of a campaign to raise $1,000,000 necessary for the removal of the university from its present temporary quarters to its new site by September, 1924.

DR. WALLACE W. ATWOOD, president of Clark University, who was granted a three-months' leave of absence by the board of trustees to visit Europe, has returned. He visited universities and colleges in Scotland, England, Belgium, Germany, Holland, France and Switzerland. He made engagements with several scholars to occupy the visiting professor's chair in geography at Clark for six months or a year.

E. A. MILLER, formerly field agent for the states relations service, United States Department of Agriculture, who for the past four months has been professor of rural economics and sociology in Oklahoma Agricultural and Mechanical College, has been named director of the Extension Division of the college, succeeding W. A. Conner, whose resignation became effective on January 1.

DR. ROBERT A. LAMBERT, assistant professor of pathology and bacteriology in the Yale University School of Medicine since 1919, is severing his connection with the university to assume the professorship in the department of pathology at São Paulo, Brazil. The chair is filled by an appointee of the Rockefeller Foundation, the professor of pathology being a member of the faculty of the school, and in academic matters to be under the direction of the dean, but appointed in cooperation with the Rockefeller Foundation.

DISCUSSION AND CORRESPONDENCE

RESEARCH IN MARINE BIOLOGY

TO THE EDITOR OF SCIENCE: Under the above heading Professor W. J. Crozier[1] has recently advocated a permanent marine biological laboratory in a tropical or semitropical situation, as a continuation of the work of the Department of Marine Biology, Carnegie Institution, so ably directed by the late A. G. Mayor. Dr. Crozier's letter seems to be a special plea for a subtropical institution. Some of his arguments, however, will not hold water. He says:

> Those whose varied experiences have provided an adequate background for judgment in this matter are unanimous in the conviction that the most suitable locations are to be found on the shores of tropical or semi-tropical seas.

[1] SCIENCE, December 29, 1922, p. 751.

Supreme variety and abundance of animals, ease of access to them throughout the year, a comparative isolation conducive to their scholarly and productive treatment—these can be found only in the warmer seas.

I am not of course informed as to whose unanimous opinion Dr. Crozier refers, but certainly nothing is more erroneous, without severe qualification, than the statement that supreme variety and abundance of animals with ease of access to them throughout the year can be found *only* in the warmer seas. Omitting possibly certain special Pacific localities, disqualified by distance and difficulty of access, there are few groups of marine animals which are not more abundantly represented on our Pacific coast (south, say, to Point Conception) than in the Bermudan-West Indian region which Dr. Crozier may have in mind as being especially favored. I speak of intertidal and very shallow water species, easily accessible. As a matter of fact the west coast fauna is phenomenally rich, being characterized in many cases by an extraordinary abundance of individuals. No warm waters can, of course, hold a candle to the luxurious marine flora of the Pacific coast.

Visiting biologists at Monterey profess themselves astounded at the wealth of shore life—the multitudes of anemones (of eight or nine species), sea urchins, sea stars, bryozoans, annelids (the largest a yard long and an inch or even more in diameter), flatworms, nemerteans, sipunculids, mollusks (consult Dall's lists), crustacea, compound ascidians. The Asteroid fauna of the west coast of North America is the richest in the world. It would be difficult indeed to offset in a West Indian locality the fifty-odd species of Monterey chitons (the largest upward of fifteen inches long), or the ninety-five species of Monterey hydroids, or the variety and abundance of pagurids. We even have a coral which is as tough as the West Indian are tender! Off shore, especially in summer, pelagic life is rich. The same story is repeated further north, notably in the Puget Sound-Vancouver Island region, very accessible.

One who is thoroughly familiar with our Pacific coast littoral finds the intertidal and shallow-water faunas of such islands as Barbados and Antigua disappointing. I understand, however, that Jamaica is somewhat better favored.

An important consideration, easily overlooked, is that few people can work *efficiently* in the tropics for more than short periods. The climate of the Tortugas, and even of Beaufort, I am informed, is very "trying" in summer. The zone of highest mental efficiency is certainly not tropical. Furthermore, in cold waters it is relatively easy to keep animals alive in aquaria and to rear eggs and larvæ. In tropical waters it is difficult. I am informed that at the Tortugas laboratory this was especially true.

Dr. Crozier rightly deplores the unavoidable fact that "the splendid material possessions of the Woods Hole Laboratory . . . are as good as wasted, so far as research is concerned, during eight or nine months of the year." He further states that "the plain fact of the matter is that the existing American institutions for research in marine biology are either more or less unfortunately situated, with regard to climatic conditions or otherwise, or else overburdened in their potentially productive seasons by the requirements of elementary instruction—necessary work, and I speak of it only with respect; but it is not enough."

In his zeal for warm seas, I fear Dr. Crozier has inadvertently overlooked two modest California institutions—the Scripps Institution for Biological Research at La Jolla, and the Hopkins Marine Station of Stanford University at Monterey Bay, both of which are in operation twelve months each year, and certainly are advantageously situated (each in its somewhat different field) as regards accessibility, climate and materials. Monterey, of course, has much the colder water—a predominantly northern fauna. Dr. Conklin stated in conversation (I write from memory) that he had never seen anywhere richer collecting. Need I mention that the climate is never uncomfortably hot, and that irises bloom in the station grounds at Christmas?

Let us by all means have a permanent laboratory, sponsored by the Carnegie Institution, but not in semitropical regions, nor in extra-territorial waters, where a war might hamper or terminate the work. If we are to go in for efficiency, let the location be chosen frankly on its merits, as regards: (1) abun-

dant, accessible, usable fauna and flora; (2) accessibility of station; (3) climate—on a basis of working efficiency during *entire* year; (4) economy in operation.

Organized research in the tropics for a definite purpose is admirable. All honor to Mayor for the splendid work he so indefatigably directed; but let us not take too easily for granted hasty generalizations concerning the superiority of the tropics or subtropics as a situation for a *permanent* marine biological laboratory. There is a glamour about the tropics which is too frequently dissipated on close acquaintance.

W. K. FISHER

HOPKINS MARINE STATION

THE MOVEMENT OF THE CENTRAL ATLANTIC RIDGE

THE soundings in the Central Atlantic area show the existence of a long ridge, which passes through the Azores and the islands of St. Paul and Tristan da Cunha. This ridge shows a bending-point in the neighborhood of the equator between the island of St. Paul and the Romanche deep.

We have pointed out in some recent publications that many of the transverse fractures which often are found near the bending-points of moving geanticlines are the surface expression of differences in rate of horizontal movement. In moving rows of islands several deep straits between the islands coincide with bending-points.

Transverse faults with a horizontal displacement are sometimes visible and where the epicenters of modern earthquakes are on transverse tectonic lines near the bending-point, similar movements are still going on at the present day.

In regions which are not accessible for direct observation, the comparative tectonic method should be applied. If a submarine ridge has a bending-point, the form of the ridge can be the result of differences in rate of movement of neighboring points in the horizontal projection of the ridge. Where the differences are greatest, epicenters of earthquakes will be numerous and if a submarine ridge shows a maximum of seismicity in the neighborhood of a bending-point, this points to movements with unequal velocity in a horizontal direction. The central Atlantic ridge shows a bending-point near the equator and a zone of high seismicity is found in the neighborhood between the island of St. Paul and the Romanche deep. The deeps in the same neighborhood, which are an abnormal feature for the Atlantic sea-bottom, may be in part of similar origin as the abnormal deep straits near bending-points of rows of islands.

The long ridge of the Central Atlantic area has been explained in several different ways, *f. i.*, as the beginning of a zone of arcuate folding, as the highest parts of a subsided continent, as a ridge of volcanic origin and as the filling of an originally narrow gaping fracture which opened to the present Atlantic Ocean by horizontal movement of continental areas.

The application of the comparative tectonic method points to movements with unequal velocity in a horizontal direction, which may have been going on since a very long time. The present S-shaped ridge may have developed from a simpler form by similar movements as those which characterize the present ridge. Anyhow, those explanations in which the horizontal movements are not taken into consideration do not seem to be applicable.

H. A. BROUWER

DELFT, HOLLAND

JANUARY 10, 1923

THE DEPRECIATION OF THE POUND

TO THE EDITOR OF SCIENCE: Advocates of the metric system will be interested to know that, beginning January 1, 1923, all transactions in grain, meal, bran, potatoes and agricultural seeds in the United Kingdom will be conducted on a price per hundred weight of 112 pounds. This is in conformity with the provisions of the Corn Sales Act of 1921. After December 31, 1922, any contract, bargain, sale or transaction in above named staples will be null and void unless made by weight only and in terms of or by reference to *the hundred weight of 112 pounds.*

Thus a step forward has been taken; but at that only a halting one. The pound is no longer 7,000 grains but only 6,250 grains because a pound now is by law only nine tenths of a pound. Dealers in farm products in Great Britain will still use the short ton and the long ton; but seemingly, the stone, the box,

the barrel, the firkin, the dry quart, the small measure, the peck and the bushel have been amortized. Peace to their ashes! The struggle is now on between the long ton, 1,016 kgs., and the short ton, 907 kgs.

But we can not say too much about British deliberation in these weighty matters; for do we not (we readers of SCIENCE) buy coal and get 2,000 pounds in a ton; while the coal dealer and the United States government get 240 pounds more on each ton? Can it be that we belong to a privileged class?

ALEXANDER MCADIE

CORRECTION

A SMALL but rather serious error occurred in my article, "Note on the fusarium wilt disease of bananas," appearing in SCIENCE of December 8, 1922. In lines 14 and 13 from the end, page 664, the word *inoculated* should be *un*inoculated.

MARK ALFRED CARLETON

CUYAMEL, HONDURAS

QUOTATIONS

THE VIRUS OF INFLUENZA

A RECENT outbreak of influenza in South Africa afforded to Sir Spencer Lister, the well-known bacteriologist, an opportunity of making some important observations which he describes in the *South African Medical Record* of November, 1922. He recalls that when influenza made its appearance in Johannesburg during the pandemic of 1918, Pfeiffer's bacillus—relatively absent in that community before the outbreak—was found by him in no fewer than 53 out of 56 cases dying with pulmonary complications; but his attempts to detect a filter-passing virus either by experiment or by culture failed. It is the more interesting, therefore, to learn that in this recent outbreak he has succeeded in satisfying himself of the presence of an anerobic filter-passing organism similar to that defined by the careful studies of Olitsky and Gates in New York, and confirmed by Gordon in the London outbreak during the early months of 1922, as reported in our columns on August 19, 1922. By sowing in Noguchi medium the filtered naso-pharyngeal washings taken within thirty-six hours of the onset of influenza Lister succeeded in obtaining a culture of the filter passer in 5 out of 15 cases. He comments on the ease with which the presence of this very minute organism may be overlooked without unusual concentration of gaze and accurate focusing. The stain which he found most successful for demonstrating the presence of the organism in films was Loeffler's alkaline methylene blue, the latter a specimen of Grubler's pre-war stock. The size of the organism was 0.15 of a micron, which is smaller than the organism found by Gordon, who estimated it to be 0.2 of a micron in diameter—a difference probably to be ascribed to the different methods of staining, as the latter observer employed prolonged staining in Giemsa's solution; he has seen preparations of Lister's organism, and agrees that it is identical with that observed by him in films of the nasal secretion and in cultures from the London cases. Lister has taken matters a stage farther than previous investigators by carrying out a preliminary experiment on human volunteers with cultures of this filter-passing organism. Sixty c. cm. of a culture in the second generation were divided into three portions—one third was placed in a spraying bottle, one third passed through a Berkefeld V filter and the filtrate placed in a second bottle, and the remaining third treated for half an hour to 56° C. and placed in a third spraying bottle. Six individuals were then sprayed with the unaltered culture, seven received the filtrate, and six the heated culture, about 1.5 c. cm. being sprayed into the nose and throat of each volunteer. The only one of these nineteen volunteers who complained of any discomfort had received the unaltered culture, and developed a typical attack of uncomplicated influenza beginning nineteen hours after spraying. The minute bodies were observed in smears of his nasal secretion, and a nasal washing was filtered through a Berkefeld candle. This filtrate on cultivation in Noguchi medium gave in five days a profuse growth of the organism. Two other individuals also in this first group that received the unaltered culture had a slight rise of temperature, and one of them showed a well marked leucopenia. Although, as Sir Spencer Lister is careful to point out, this result is not sufficiently conclusive to establish the filter passer as the cause of influenza, it is distinctly

encouraging, and further reports of his enterprising investigations will be awaited with interest.—*The British Medical Journal.*

SCIENTIFIC BOOKS

Geology of the Tertiary and Quaternary Periods in the Northwest Part of Peru. By T. O. BOSWORTH. With an account of the Paleontology by Henry Woods, T. Wayland Vaughan, J. A. Cushman and others. Macmillan & Co., 1922.

This book of 434 pages is devoted to the post-Cretaceous geology of the coastal strip, fifteen to forty miles wide in northern Peru, and extending from Tumbez southward to Payta, a distance of about one hundred and fifty miles. It is made up of five rather distinct and largely uncoordinated parts: (1) Tertiary Geology; (2) Tertiary Paleontology; (3) Quaternary Geology; (4) Desert Geology; (5) Occurrence and Exploitation of Petroleum; all but the second being by the author. The book is a result of several years of professional work in the region and is a most important addition to our knowledge of it.

The geological elements comprise the Andean chain of the Amotape Mountains on the east, consisting of slates, quartzites and granites of Paleozoic and Mesozoic age, and lying west of these mountains the present desert plain made up of Eocene and Miocene, littoral and shallow water formations, and a series of Pleistocene wave cut terraces and beaches or Tablazos. The Oligocene Ovibio formation, the lower Miocene Heath formation, the upper Miocene Talara formation and the Pliocene Payta formation described in this region by Grzybowski and others are shown not to exist.

The Eocene consists of two formations with a total thickness estimated to be more than twelve thousand feet and consisting of clay shales, more or less calcareous sandstones and beach pebbles. The oldest of these, the Negritos formation, is especially rich in gastropods and is divided into an older Turritella series and a younger Clavilithes series. The fauna is shallow water and largely molluscan, but containing a few crustaceans and fish teeth. It shows a marked resemblance to that of the Wilcox and lower Claiborne of our gulf states and is indicative of a seaway between the two regions. Frequent mention is made of the presence of a species of Aturia in the Negritos. The reviewer's collections from that formation contain no Aturia but do contain abundant specimens of a large Hercoglossa.

The Negritos is followed by some five thousand feet of lithologically similar beds constituting the Lobitos formation. The fauna is essentially similar to that of the Negritos but sparser, and contains Foraminifera of several species, notably the genera *Lepidocyclina* and *Orthophragmina,* and is considered to be upper Eocene in age.

The Zorritos formation, which makes up the balance of the Tertiary, is estimated to be about five thousand feet thick and is considered as Miocene in age, although the author seems to be in doubt as to there being any break between it and the Eocene Lobitos formation. The author did little detailed work in the more northern region where the Zorritos is well exposed, consequently but three pelecypods and six gastropods are described from it. In the paleontology of the Zorritos formation published by Spieker[1] before Bosworth's book reached America, there are described forty-four gastropods and fifty-seven pelecypods, and the age was definitely proven to be lower Miocene. Bosworth does not mention the three hundred feet of variegated, partly continental and lignitic Zorritos which is so conspicuous in the Zorritos district.

The Quaternary is represented by a series of four (possibly more) sea-cut terraces, the oldest of which reached inland almost to the Amotape Mountains. These terraces (Tablazos) are named the Mancora, Talara, Lobitos and Salina and record extensive oscillations of level. It seems unfortunate that for the second Bosworth uses a name already used for a supposed Miocene formation in this region, and that for next to the last he uses a name already applied by him to an Eocene formation in the region. These tablazos consist of thin sheets of light colored beds of shell rock, marl, sand, sandstone and conglomerate, very variable laterally, quite fossiliferous, and lying practically horizontally on a plane of marine erosion on the much faulted underlying Tertiary. The pebbles are beach pebbles of volcanic rocks from the western Andes, sub-angular quartz-

[1] Spieker, E. M.: *Johns Hopkins Studies in Geology,* No. 3, 1922.

ites, slates and granites from the Amotape mountains, and those derived from the underlying Tertiary.

The intense block faulting of the Tertiary preceded the Tablazo period, but there has been subsequent differential warping since the surface of the oldest or Mancora tablazo declines from an elevation of eleven hundred feet at Mancora to two hundred feet at Payta. The younger tablazos are progressively less extensive and less elevated, and the latest or Salina plain has been brought above sea level by a recent uplift of from ten to fifteen feet. The contemporaneous breccia fans bordering the mountains, and river terrace and other deposits are also dealt with. The author is impressed with the vast time involved in the oscillations and consequent events of Quaternary time in this region, amounting, if one may take his remarks on page 259 literally, to some five million years.

Part 4 is devoted to desert conditions and processes and is a most valuable description and discussion of land forms and processes under conditions which are little known to the average geologist. Part 5 is a not altogether satisfying account of the petroleum industry in the region. The chapter on the occurrence of oil in fault blocks, often of small size, is as interesting as it is unusual.

In conclusion the work is a most commendable one and indispensable to any one interested in or contemplating working in the region. As an example of book making there are some features that might have been better done. The five parts into which it is somewhat artificially divided are not coordinated and there is considerable repetition. One questions the wisdom of splitting it up into 76 chapters, some of which are only a paragraph in length, and in a book with one hundred and fifty figures besides many plates the readers might dispense with several views of the author at the plane table, which is a well-known instrument even in Peru. With all due appreciation of this as the first comprehensive work on the region it would seem that previous workers have been given but slight consideration, and in particular the main stratigraphic units do not differ greatly from those of the Cuerpo de Ingenieros de Minas of Peru, which is not mentioned.

The author's insistence on a range of pre-Tertiary desert mountains, which he states were higher in earlier times than they are at present, may well be questioned. Obviously the Andean region underwent changes of level both by uplift and erosion throughout its history and some of its rocks were folded in very ancient times, but I am not prepared to accept the author's conclusions, based on the absence of Eocene deposits elsewhere on the west coast of South America to the southward of this region, the enormous estimated thicknesses of the Eocene, and the presence of Andean pebbles, as proof of a high range, particularly as the fossil plants found in the Zorritos formation[2] show no evidence of desert conditions or of high mountains across the path of the easterly humid trade winds, and the topographic form of the mountains themselves precludes such a conclusion, as does also the paleobotanical evidence of Pleistocene elevation derived mostly from Bolivian localities, but recently discovered as near the region treated by Bosworth as Cajamarca in northern Peru.

EDWARD W. BERRY
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SPECIAL ARTICLES

THE LOCATION OF ENERGY

A CALCULATION of the mass of an electron, based upon the modification of electromagnetic theory proposed in a recent paper,[1] has led to the surprising result that the mass inside an electron in uniform motion, when calculated from the momentum, is equal but opposite in sign to the mass outside.

Before the calculation was carried to eight decimal places the sum of the two masses appeared to be a small positive multiple k of e/ac^2, where e is the charge of the electron, a its radius and c the velocity of light. The boundary of the electron is supposed to be a sphere of radius a when the electron is stationary.

It was thought at first that this calculation indicated that a must be much smaller than is generally supposed, of the order 10^{-17} cm., for

[2] Berry, E. W.: *U. S. Natl. Mus. Proc.*, Vol. 55, pp. 279-294, 1919.

[1] *Physical Review*, September, 1922.

instance, but further consideration has led the writer to the view that the equality of the two masses is exact and that it may be advantageous to regard the mass of the electron as being situated inside the electron rather than outside.

A few remarks will now be made to make this point of view seem reasonable. It is supposed in the new theory that an electric charge produces both a vector field (the electromagnetic field) and a scalar field which may be specified by means of retarded potentials and which exists both inside and outside the electric charges. The scalar field is derived from a single potential Ψ which reduces to the ordinary electrostatic potential when all the electric charges are stationary but differs from it in general when charges are in motion.

Associated with the two fields there is a tensor T whose components give the densities of energy and momentum and also the fluxes of these quantities. Two tensors T_1 and T_2 were mentioned (in the paper) which would give no radiation of energy and momentum to infinity on the whole when an electron describes a periodic orbit under the influence of an electrostatic field of infinite mass. By slightly modifying the second tensor it is possible to retain the property just mentioned and arrive at the same expression for the body force per unit volume as was obtained from the first tensor, except that there is a difference in sign. This modified form of the second tensor will be called T_2. In addition to these a third type of tensor must be considered.

A state of the ether will be regarded as *chaotic* when there is no flow of energy, no density of momentum and a density of energy which is constant and the same for different standard observers that are moving uniformly relative to one another in various directions. The flow of momentum across a surface is then always normal to the surface and on the whole there is no flow of momentum into or out of a closed surface which is fixed relative to a standard set of axes. The ether thus not only exerts no body force on the ether within the surface, but the surface forces depending on the flow of momentum form a system in equilibrium. The tensor T_0 corresponding to a chaotic state of the ether will be called a *chaotic tensor,* the stress-system represents a constant positive or negative pressure which is equal in magnitude to the density of energy. It is found that the best results are obtained by assuming that the tensor T associated with a system of electric charges is of type $T = T_0 + \frac{3}{8}T_1 - \frac{5}{8}T_2$, where T_0 is a chaotic tensor whose magnitude inside an electron is different from its magnitude outside, the difference being sufficient to make the stress across each surface element of the electron continuous.

In order to retain the Newtonian law of motion in the form, rate of change of the momentum in any region equals the impressed force, it seems advisable to depart from the usual convention of electromagnetic theory and change the signs of the densities of energy and momentum and that of the flow of energy. It may be mentioned that the usual convention was adopted in order to force the energy and mass of an electron to be outside the electron, the result being that the rate of change of the electromagnetic energy inside the electron is represented as being equal to minus the resultant of the body and surface forces. With the assumption, however, that there is no momentum inside, the body force is shown to be equivalent to a surface force which is in accordance with the idea of Maxwell and others that all actions in the ether are really contact or surface actions.

This principle is also adopted in the new theory, but the body force is supposed to vanish in virtue of a set of equations which are assumed to be equivalent to the equations of motion. The new theory must be regarded simply as an experiment, its adoption or rejection must depend entirely upon whether the equations of motion do or do not give results that correspond with the facts.

So far the results seem rather promising. A mathematical reason is found why an electron, which has returned to rest after any type of motion, may have the same size and mass as before. If, moreover, we adopt as a criterion for the possibility of a given steady state of motion the requirement that there should be no radiation of energy to infinity we can say that

an electron may apparently describe a circular orbit round a positive nucleus of infinite mass, but two electrons at opposite ends of a diameter could not describe such an orbit because there would be a continual radiation of energy to infinity.

The chief disadvantage of the new theory is that it makes the electromagnetic energy negative and requires that negative electromagnetic energy should be radiated, when an electron is accelerated, to compensate for the positive energy, depending on the scalar potential Ψ, which is radiated in various directions.

The existence of negative energy in the ether may be avoided by adding a chaotic tensor of suitable magnitude, whichever type of energy we regard as positive; the magnitude of this tensor outside the electron is, however, greater when electromagnetic energy is regarded as negative than when it is regarded as positive. This may be regarded as a disadvantage of the convention adopted here, consequently it seems advisable to leave the question of sign open and to assume temporarily that T_0 is zero outside the electrons and positive nuclei. Then, when the question of sign has been decided, a positive chaotic tensor may be added, if necessary, to make the density of energy everywhere positive. When we speak of negative energy we mean simply that its sign is different from that of the energy inside an electron and that it represents a deviation from the chaotic state in which there is a uniform distribution of energy. If we suppose that the present ordered state of the ether has been derived from a chaotic state, then the idea that a surplus of energy in one place is balanced by a deficiency in another seems reasonable. With this supposition, too, the total momentum must be zero, a condition which is satisfied in the case of a single electron if, as we found by calculation, the momentum inside is equal but opposite in sign to the momentum outside. This means that the mass of the electron can be calculated from conditions inside just as well as from conditions outside.

When an electron is moving along a straight line with uniform velocity v the contribution of the chaotic tensor T_0 to its internal energy is proportional to $\sqrt{1 - \frac{v^2}{c^2}}$ since the volume is diminished in the ratio $\sqrt{1 - \frac{v^2}{c^2}} : 1$ on account of the Lorentz-Fitzgerald contraction. The chaotic energy inside the electron, which is greater or less than the normal amount, according to the convention as to sign, may thus be regarded as proportional to $m_0 \sqrt{1 - \frac{v^2}{c^2}}$ where m_0 is the stationary mass. Now this is just the type of expression that occurs in the form of Hamilton's principle that has become so important in the modern theory of relativity, consequently the assumption of a chaotic tensor may be necessary for a physical interpretation of the Principal of Least Action.

The idea that the electromagnetic energy in a wave of light is negative may seem strange and contrary to the fact that light exerts a pressure, but it should be remarked that in our opinion the energy in a wave of light is really positive and depends for its positive quality on the disturbance specified by the retarded potential Ψ. So long as there is positive energy on the whole and a flow of positive energy in the direction of the waves there will be a pressure proportional to the density of energy.

In conclusion it may be remarked that the tensor, T, for an electron has been chosen so that in the state of uniform motion the mass, m, and total internal energy, E, are connected by Einstein's relation, $E = mc^2$.

The constant k in the expression for the mass appears to be $\frac{1}{16\pi}$ but it is not certain that this is the value which is actually measured, for, judging from a rough calculation, the total force exerted on an electron by the scalar and vector fields is, in a simple case at least, three times the ordinary electromagnetic force, the force exerted by the scalar field being twice as big as that exerted by the electromagnetic field. It should be remarked that both the total energy and the electromagnetic energy can be regarded as positive if an additional tensor is introduced for the interior of an electron and the usual convention of signs adopted. The value of k is then $\frac{1}{2\pi}$.

H. BATEMAN

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THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

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Retiring vice-president, W. D. Harkins, University of Chicago, Chicago, Ill.

Secretary, W. D. Harkins, University of Chicago, Chicago, Ill.

(Report by W. D. Harkins)

The general opinion expressed by the chemists in attendance at the Boston meeting was that the program gave an extremely interesting and important summary of progress in this science, particularly with reference to a number of topics which are of great interest to other scientists and to the public.

The four principal topics considered were atomic structure, photochemistry and photochemical synthesis, colloids and colloidal behavior, and the ionization of salts in solution. In addition the chemists were invited to attend a symposium arranged by the physics section, upon a subject of extreme importance to chemistry, that of ionization potentials and atomic radiation.

Symposium on Atomic Structure

One of the most interesting subjects presented at the symposium on atomic structure was that of the size of atoms, especially as they exist in solids. Only a few years ago it was believed that the atoms in solids occupy only one fourth to one half the total volume at any instant, but that each atom vibrates with a high frequency in the space between the adjacent atoms available for this purpose. It was supposed that in the compression of the solid the atoms are merely forced closer together, without any distortion of the atoms themselves. About fifteen years ago Professor T. W. Richards of Harvard University began to develop the distinctly novel idea that the atoms occupy most of the space in a solid and that in any considerable decrease of volume the atoms themselves are diminished in size. This gave rise to his celebrated theory of "compressible atoms." In 1921 Professor Richards showed that the dimensions of atoms could be calculated from the compressibilities of the solids in which they exist, provided data are available for a set of compounds related to each other chemically in a sufficiently simple way. For example, he obtained such data for the fluorides, chlorides, bromides and iodides of lithium, sodium, potassium, rubidium and caesium. Using an ingenious extrapolation to zero compressibility he was able to show that the values correspond to a diameter of 2.8 Ångstrom units (ten-millionths of a millimeter) for the chlorine atom in common salt and other similar compounds. The interesting feature of the results is that the diameters of the atoms, especially those of the metals, proved to vary with the nature of the compound in which they are found. Thus the sodium atom is smaller when combined with chlorine (as it is in common salt) for which it has a high affinity, than when it is united to bromine or iodine for which its affinity is less. Professor Richards's most recent work, as described in his paper, has been to devise a new and more directly experimental method for calculating the dimensions of atoms, with the remarkable result that the values obtained are the same, within the limits of error, as those given by the older method. The new method depends upon the idea that the element sodium acts under compression exactly as potassium would act under high pressure. The attractive forces between the atoms is such that the internal pressure in sodium under ordinary conditions is 20,000 atmospheres higher than that in potassium. By using the data on these two elements, he is able to show how the contraction which occurs in the formation of a salt from the elements may be distributed between them. The results throw much light upon the mechanism of chemical combination, the magnitude of the internal pressures involved and many allied phenomena.

It is found that the contraction which occurs in the formation of a salt from the elements involved is of the order of magnitude to be expected from a consideration of the compressibilities and the internal pressures believed to exist in them. The fact that the thus computed order of magnitude of the compressibility of the salt is the same as that of the actual compressibility determined by measurement, seems to show conclusively that the internal pressure

is the cause which determines the volumes of liquids and solids.

A closely related topic, that of the changes of volume which occur in the formation of solid salts from the elements which constitute them, and the further volume changes when these salts are dissolved in water, was discussed by Professor Gregory P. Baxter, of Harvard University. It is well known that his results are the most accurate of those obtained in this field, and they have been used as the basis of a number of interesting volume relations developed recently in connection with the development of the Born and Landé theory of atomic structure. Professor Baxter demonstrated that the changes of volume which occur either in ordinary chemical combination or in the process of solution are the result of several factors, the compressibility of the material and the chemical affinity being the principal properties involved. It was found that the volume of salt in a solution is an additive property of the volumes of the ions which constitute it even in concentrated solutions (up to 5 normal) and at all temperatures. This is of importance in connection with the application of the theory of electrolytic dissociation.

An interesting and important paper on the relation between X-rays and atomic structure, and on the application of X-rays in the determination of crystal structure, was presented by Professor William Duane of Harvard, the leading American authority upon this subject. He showed in a simple way the relations exhibited between the emission and absorption of X-rays and the structure of the atoms as interpreted in the light of the quantum theory. Two kinds of X-radiation have been discovered: The general or continuous spectrum, and the characteristic X-ray spectrum. The wave lengths of the latter depend upon the atomic number of the chemical element used as a target in the X-ray tube, while the former contains all wave lengths down to a well-defined minimum, the value of which depends upon the difference in potential (V) applied to the X-ray tube. The relationship supposed to hold in this connection is the quantum relation of Planck as expressed by the equation of Einstein:

$$Ve = h\upsilon = h\frac{c}{\lambda}$$

in which e is the charge on the electron, υ is the frequency of the radiation, λ is its wave length, and h is the quantum constant.

In 1914 Professor Duane tested this quantum law, using the limit of the general radiation, and found that it holds with great exactness, so that this method gives one of the most precise methods for the determination of the value of the quantum constant (h). This equation has recently been used by Clark and Duane as the theoretical basis of the most precise method yet devised for determining the distance between the atomic planes in a crystal, in which case the equation is most simply applied in the form:

$$V\lambda = h\frac{c}{e} = 12{,}354$$

in which V is in volts and λ in Ångstroms.

In the experiments the crystal is so set that the X-rays reflected by the planes whose distance apart it is desired to measure enter an ionization chamber filled with ethyl bromide vapor. The voltage is then reduced gradually, and at a certain definite voltage it is found that the ionization in the chamber disappears. This is the voltage corresponding to the limit of the general radiation described above. The distance d between the atomic planes is obtained by the use of the general equation for a grating,

$$d = \frac{n\lambda}{2\sin\theta} = \frac{12{,}354}{2V\sin\theta}$$

in which n is a whole number and θ is the angle corresponding to the proper peak in the ionization current diagram obtained by rotating the crystal. In the case of potassium iodide this was found to be 3.534 Ångstrom units, which corresponds almost exactly to the density of the same salt as determined by Baxter.

Dr. George L. Clark, of the same laboratory, discussed the application of this method to the determination of the crystal structure of caesium tri-iodide. This work is remarkable in that it represents the first successful attempt to determine the structure of a rhombic crystal, all crystal structures heretofore investigated being of a simpler type. It is found that the atoms of caesium lie at the corners of a rhombohedron, and that diagonally across this solid figure three iodine atoms are distributed in such a way as to divide the distance equally between them. The completion of this work, together with the determination of the structure of potassium tri-iodide, marks an important

step in the study of the structure of complex inorganic compounds. The most interesting feature of the experimental work on caesium tri-iodide is the discovery of a method of fixing the positions of atoms of different elements which have practically the same atomic weight, as is the case with caesium and iodine. This was done by causing each atom to register its own spectrum.

The University of Chicago was represented by two general papers, one on ionization and resonance potentials and their importance to chemistry, by W. Albert Noyes, Jr., and the other on the separation of isotopes, particularly as carried out in the Chicago laboratory, by R. S. Mulliken. In addition to a general treatment of his subject Dr. Noyes discussed the idea of Gibson and Noyes that in most cases the potential required to produce luminosity in a gas, when a heated cathode is used, is an integral multiple of the ionization potential. At the request of the chairman, and in answer to numerous questions from the floor, Dr. Irving Langmuir discussed this paper at some length.

Dr. Mulliken showed very clearly that many of the methods proposed for the separation of an element into different types of atoms or "isotopes" have failed thus far. All of the methods which have proved successful may be classified under the one term "diffusion methods," whether the diffusion takes place through a membrane as in the experiments of Harkins and his collaborators, Broeker, Hayes and Liggett, using chlorine in the form of hydrogen chloride, or through the surface used as a membrane, as in the work of Broensted and Hevesy, Mulliken and Harkins, and Harkins and Madorsky, in which mercury has been separated by vaporization at low pressures. Dr. Mulliken described a very rapid apparatus which he has recently constructed, in which mercury, separated to some extent by vaporization, is further separated by diffusion of the vapor through a membrane of filter paper. The centrifugal method, which has thus far failed, seems to give promise of becoming the most rapid of all methods thus far proposed, provided the structural problems of the centrifuge are properly solved. Dr. Langmuir suggests that Hertz has devised a method of applying the diffusion method which might lead to a rapid separation, but a later consideration of this method by Dr. Mulliken seems to indicate that the method is unlikely to show any marked superiority over other diffusion methods, and *may* be decidedly inferior.

Professor Kraus, of Clark University, gave a valuable review of his extensive work upon the characteristics of the metals, salts and non-metals, or of metals, electrolytes and non-electrolytes. Professor Kraus has made extensive studies of the behavior of substances when dissolved in solvents other than water, such as ammonia, sulphur dioxide, etc. He has been able to show that a substance which is usually considered as a metal, such as sodium, may act as a salt when dissolved in the proper solvent. Thus this is the case when sodium is dissolved in liquid ammonia.

Professor Kraus presented a new classification of substances in four groups, as follows: (1) Electrolytes, which conduct even in the pure state; (2) non-electrolytes, which conduct neither when pure nor when in solution; (3) meso-electrolytes, which show a slight conducting power both in solution and when pure; (4) pseudo-electrolytes (like the acids), which are non-conductors when pure, but ionize in solution because they combine with the solvent.

The address of the retiring vice-president of the section was on the subject of atomic structure and the general periodic system of the isotopes,[1] and will be published in a later issue of SCIENCE. Many interesting photographs of the tracks of helium atoms (α-particles) in gases, as obtained by R. W. Ryan and the speaker, were exhibited.

Colloids

One of the features of the meeting was an illustrated address on "Proteins and the theory of colloidal behavior," in which Dr. Jacques Loeb, of the Rockefeller Institute for Medical Research outlined the theory presented in his recent book of the same title. He discards the older idea that the swelling of protein gels is due to the preferential absorption of certain ions, notably of hydrogen and hydroxyl,

[1] See a paper entitled "The Stability of Atom Nuclei, the Separation of Isotopes, and the Whole Number Rule," by William D. Harkins, *J. Franklin Institute*, Vol. 194, August to December (1922), and Vol. 195, January to March (1923).

since his experiments indicate that proteins behave as definite chemical compounds of an amphoteric nature, that is, in the presence of acids they act as bases, and in the presence of bases they act as acids. Dr. Loeb considers that the erroneous older view has held sway so long only on account of the general failure to measure the hydrogen ion concentration of the solutions used in the investigations.

It is concluded that the basis of colloidal behavior is to be found in Donnan's theory (1910) of membrane equilibria. Donnan found that when a membrane separates two solutions of electrolytes, one of which contains an ion which cannot diffuse through the membrane which is penetrable to the other ions, the result will be an unequal distribution of the diffusible ions on the opposite sides of the membrane. Thus if there is a solution of NaR (where R^- is the ion which does not pass through the membrane) on one side, and NaCl on the other of the membrane represented by the vertical line below

$$\begin{array}{r|l} Na^+ & Na^+ \\ R^- & Cl^- \end{array}$$

there will follow a diffusion of NaCl from left to right as represented below

$$\begin{array}{r|l} Na^+ & Na^+ \\ R^- & \\ Cl^- & Cl^- \end{array}$$

until the product of the concentrations of the sodium and chlorine ions on the right becomes as great as the similar product on the left, which represents the attainment of a state of equilibrium. This reminds the reviewer of very similar relations worked out even earlier by Haber (in 1909). In any event, Dr. Loeb makes a very strong case for the importance of this relation in the interpretation of the action of proteins. He considers that the famous Hofmeister series of ions has been obtained on the basis of erroneous reasoning.

The chemistry of the photographic process was discussed in an illustrated address by Dr. C. E. K. Mees of the Eastman Kodak Company, who described the methods of investigation in use in the laboratories of his own company and in those of various European investigators.[2] One of the most interesting of the recent results is concerned with the application of the quantum theory to the theory of development of the photographic plate. The silver chloride in a photographic plate exists as small crystals belonging to the regular system and imbedded in the gelatin. Each of these crystals is commonly called a grain. These grains often gather into clumps, which tend to develop together, so that there seems to be a process of "infection." In the early applications of the quantum theory it was considered that one quantum of energy should make a single grain developable, but it has recently been demonstrated in the laboratories of the Eastman Kodak Company that it is necessary to supply several hundred quanta per grain. It is found that a grain may be more or less exposed, and that the development depends upon the reduction potential of the developer which is used. Dr. Mees showed that if the number of grains developed per 1,000 grains present is plotted on the Y-axis, and the wave lengths of the light used upon the X-axis, a Gaussian type of curve is obtained in the case of par-speed portrait film, and a very different type of curve when standard slow speed lantern slides are used, at least for the wave lengths so far investigated.

Ionization of Salts in Solution

Much interest was excited by the program of the symposium on the ionization of salts in solution, in which Dr. D. A. MacInnes of the Massachusetts Institute of Technology presented the argument for the newer theory, which is that strong electrolytes are practically 100 per cent. ionized in aqueous solutions, and in other solvents similar to water. The viewpoint of the classical or Arrhenius theory was to have been presented by Dr. James Kendall of Columbia University, but on account of a severe New England snow storm he did not arrive until shortly after the meeting was over. This made it necessary for Dr. MacInnes to present both sides of the question, which he did very ably.[3] The subject was discussed by W. Lash Miller, Charles A. Kraus, E. W. Wash-

[2] See "Recent Advances in Photographic Theory," by C. E. K. Mees, *J. Franklin Inst.*, 195, 1-21 (1923).

[3] It is hoped that the paper of Dr. MacInnes may be secured for publication in a later issue, so what is presented here represents the point of view of the discussion rather than that of his paper.

burn, W. D. Harkins, and a few others whose names were not recorded. There seemed to be a general agreement that the general question at issue is not at all the relative value of the newer theory as opposed to the original form of the Arrhenius theory, but rather its merits in contrast to those of the most recent form of the classical theory. Thus practically all of the upholders of the classical theory no longer think of the existence of molecules of sodium chloride (NaCl) as such in an aqueous solution, but they assume that *at any instant* a part of the salt is less ionized than the rest in the sense that the ions of opposite charge are closer together, and are therefore less independent as carriers of the current. Unfortunately, from the standpoint of a clear presentation of the subject, the meaning of the term "ionized" has been entirely changed in later years by its use in a different sense from the original one by workers in physics. It is now customary to say that in solid sodium chloride there is complete ionization, and the upholders of the classical theory of ionization in solution have always assumed that the ionization in aqueous solution is more marked than in the solid state. It therefore becomes necessary to devise another term to replace the word ionization. Several years ago it was suggested that the term "electrolytic dissociation" might well be used in all discussions of the theory in place of the word "ionization."

On the whole the impression gained from the meeting was that the upholders of the two theories have the same ideas, but talk about them in different words. However, it would seem that in so far as the 100 per cent. theory assumes independent migration of the ions, and the independent influences of the ions in connection with solubility effects, it is in error, since these assumptions are contrary to the facts as represented in the work of Braley on the transference of sodium in a 0.01 normal sodium chloride with 0.1 normal potassium chloride present. In this case the sodium is not transferred at all, which is a result wholly unexpected from the point of view of the 100 per cent. theory. The solubility relations of salts of the type of calcium and magnesium sulphates also give evidence of the formation of complexes.

The principal support for the 100 per cent. theory lies in the additive nature of the properties of salt solutions, but this is a fact well known to the upholders of the older theory. One of the principal arguments of the newer theory is based upon the fact that the thermodynamic potential or the activity of the salt in solution varies in quite a different way from the conductivity ratio. No one at the meeting seemed to defend the present values of the percentage dissociation listed in text-books, such as the value 86 per cent. given for potassium chloride at 0.1 normal concentration. Thus the value of the newer idea may be that it indicates that the classical theory has been expressed in too dogmatic a way. What seems to be most needed in connection with this subject is a new terminology. It is probable that ion aggregates of the type $Cl^-Na^+Cl^-$ exist, at least for a very minute interval of time, in aqueous solutions. These were formerly designated as "intermediate ions" since the term complex ions, better in many respects, was reserved by custom for more stable aggregates. If it is to be assumed that these aggregates are completely ionized it would seem that the term "ion aggregate" would serve as well as any other. The new theory seems to give its greatest promise along the line partly developed by Milner—that of working out the general kinetic theory of electrolytic solutions on the basis that the ions preserve their charges, but that they unite more or less with ions of the opposite charge to form aggregates which are less affected in their motion by the applied potential. It is apparent that much of the work now appearing in support of the newer theory is related specifically to neither theory, since it simply involves the finding of equations containing enough constants to enable them to represent the facts. While this is a very valuable method of progress, it is well known that such equations can be developed in the case of almost any type of related phenomena, so the existence of such equations is not evidence in favor of any specific theory until it is shown that the theory is a necessary basis for the equations. The above discussion of the symposium on ionization does not properly represent the discussions presented, since they embodied a great deal of detail, but it represents simply one view of the situation as suggested to the mind of the individual asked